Space Weather Technical Forecast

Issued on Saturday, 21 October 2023 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Weak CME arrivals possible, with a chance of G1/Minor Storm intervals on Day 1 (21 Oct), declining thereafter.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity as recorded at GOES16 has been Low over the past 24 hours, with only low level C-class flares. There are currently six sunspot regions on the visible disc, all of which are relatively small and simple, with only AR3469 in the northwest showing some minor development in recent hours.
No Earth directed CMEs have been seen in coronagraph imagery during the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE and DSCOVR at L1, shows signs of enhancement, probably CME influence starting around 20/1230 UTC. The solar speed has been at background levels throughout and is currently around 310 km/s. The density has been near or rather above average with a peak of 22ppcc at 20/1210 UTC. The IMF was weak at first, but maintained generally moderate levels throughout. The Bz was weakly variable, but gradually became moderately southward directed from 20/1610 UTC. The phi angle was positive (away from the Sun) throughout. Geomagnetic activity was Quiet to Unsettled (Kp 1-3), before becoming Active to minor storm/G1 (Kp4-5) after 21/0000 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels.
GOES16 high energy (greater than 2MeV) electron flux was mostly at background levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold on a steady trend. The observation at 21/0000UTC was 1.9e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low solar activity is likely to continue. There is just a slight chance of M-flares, more so later in the period if we see new regions rotating onto the disc.

Solar Wind / Geomagnetic Activity: The geomagnetic forecast is complex and carries high uncertainty. There remains two probable Earth directed CMEs. The first is expected to largely miss, but with the potential for a glancing impact in coming hours. The second CME also has a slight chance of glancing impacts shortly afterwards. There is potential for some minor High Speed Stream (HSS) coronal hole fast wind enhancement from CH62/- on Day 1 and from CH63/- on Day 3 into Day 4 (23-24 Oct). Geomagnetic activity starting at Unsettled to Active levels (Kp3-4) and a continuing likelihood for Minor Storm intervals/G1 (Kp5). Activity then probably return to mainly Quiet (Kp1-2) conditions from Day 2 (22 Oct). Unsettled to Active (Kp3-4) intervals are then possible, with the arrival of the anticipated minor coronal hole fast wind later in the forecast period.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is

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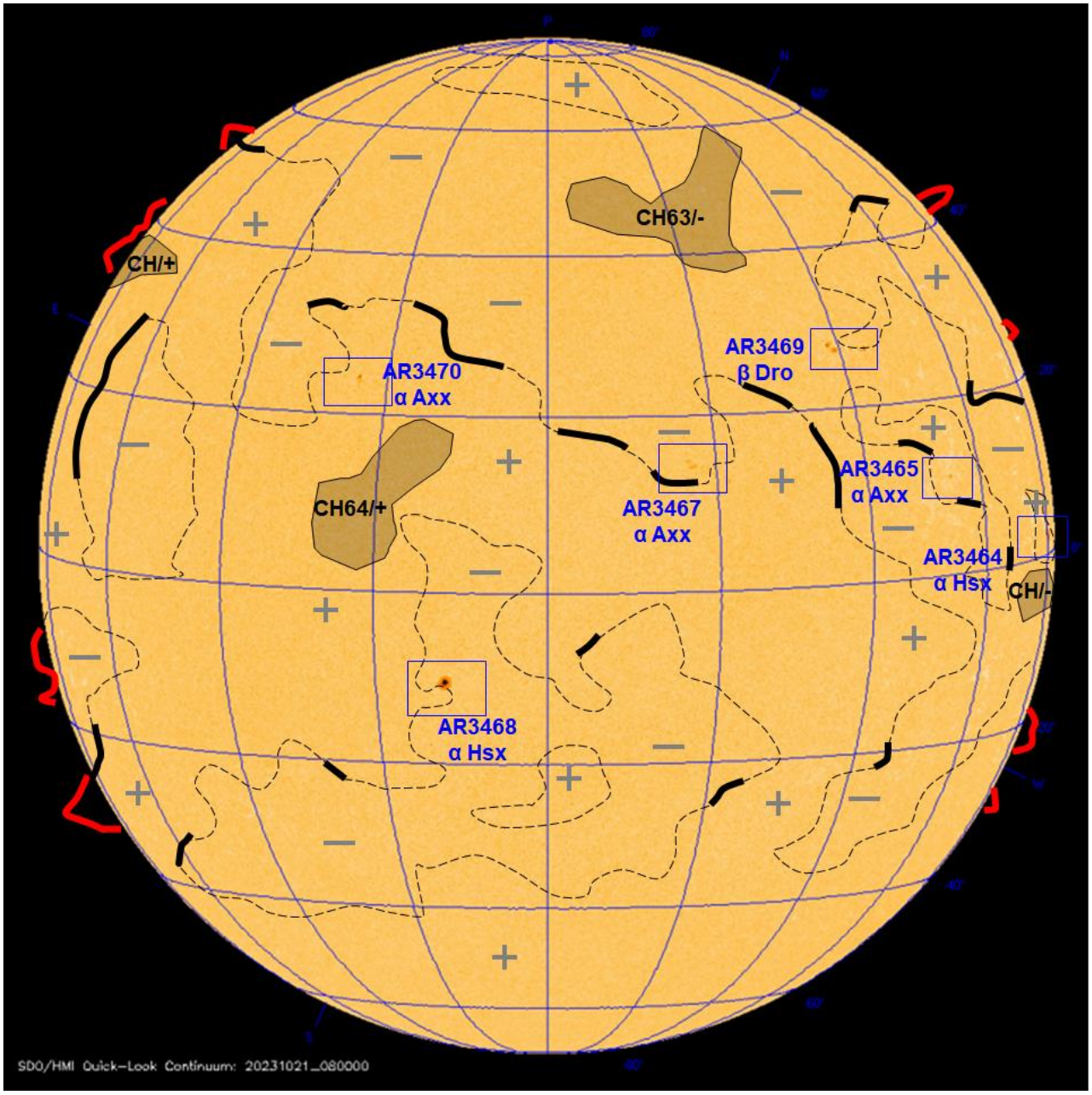
expected to persist at background levels.
High energy electron flux (greater than 2MeV) is expected to be at background levels, perhaps rising to moderate depending on the strength of any CME or HSS enhancements. The associated 24-hour electron fluence is expected to remain below Active (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 0800 UTC, 21 October 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

The geomagnetic forecast is complex and carries high uncertainty. Two Earth directed CMEs feature in the guidance. The first was observed from a filament eruption near ex-AR3463 off the southwest disc early on 17 October. This is expected to largely miss, passing ahead and south of Earth, but with the potential for a glancing impact in coming hours. The other CME was observed from the southeast around 18/0530UTC. This has been assessed as passing to the south and behind Earth shortly afterwards, also with a slight chance of glancing impacts. These two features could combine to arrive together. There is potential for some minor High Speed Stream (HSS) enhancement from CH62/- on Day 1 and CH63/- later on Day 3 into Day 4 (23-24 Oct). Both are negative polarity, and are not favoured for strong geomagnetic connection at this time of year.

Geomagnetic activity starting at Unsettled to Active levels and a continuing likelihood for Minor Storm intervals. Activity then probably return to mainly Quiet conditions from Day 2 (22 Oct). Unsettled to Active intervals are then possible with the arrival of the anticipated minor coronal hole fast wind later in the forecast period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	20	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/1430	Partial	Filament	SW	420 km/s	21st	Very low confidence.
18/1132	Partial	Filament	SE	610 km/s	21st	Very low confidence.

Figure 2: : MOSWOC Enlil and ensemble, showing potential CME arrivals during coming hours.

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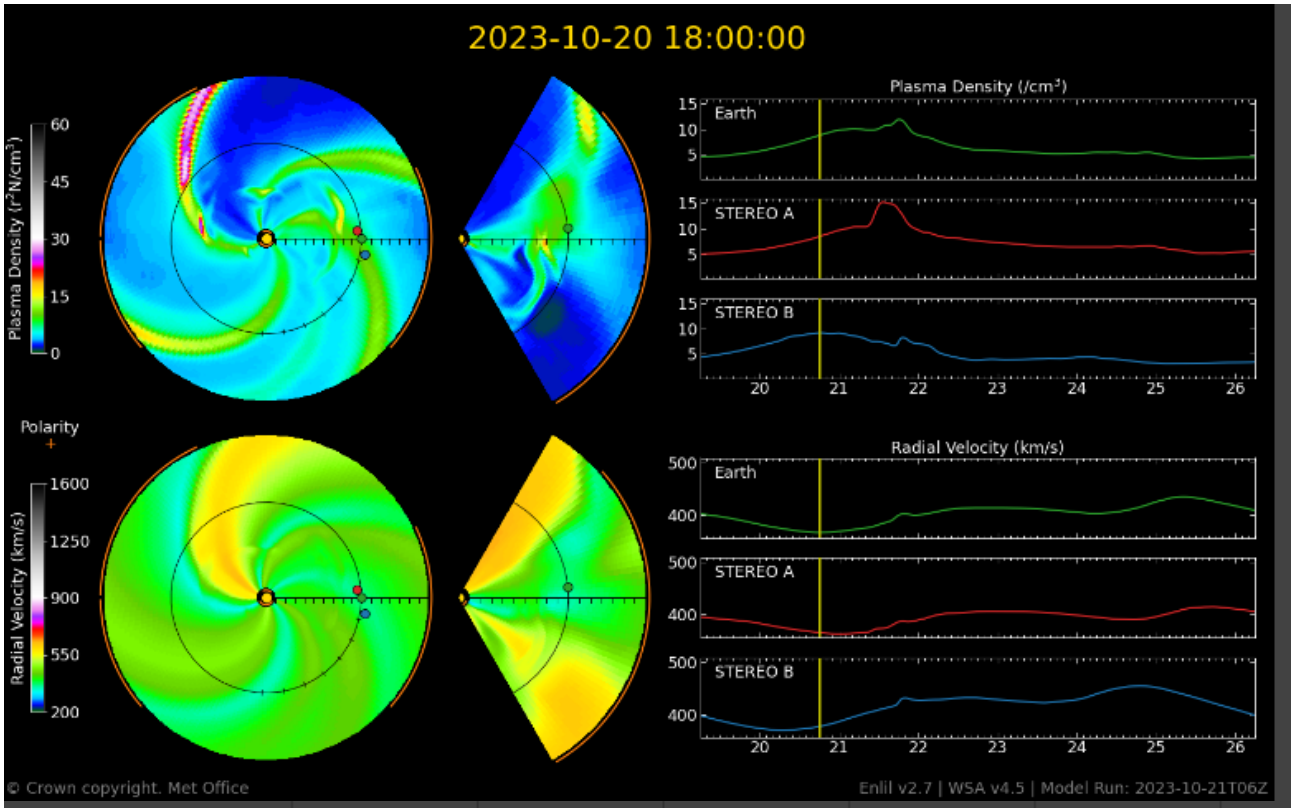
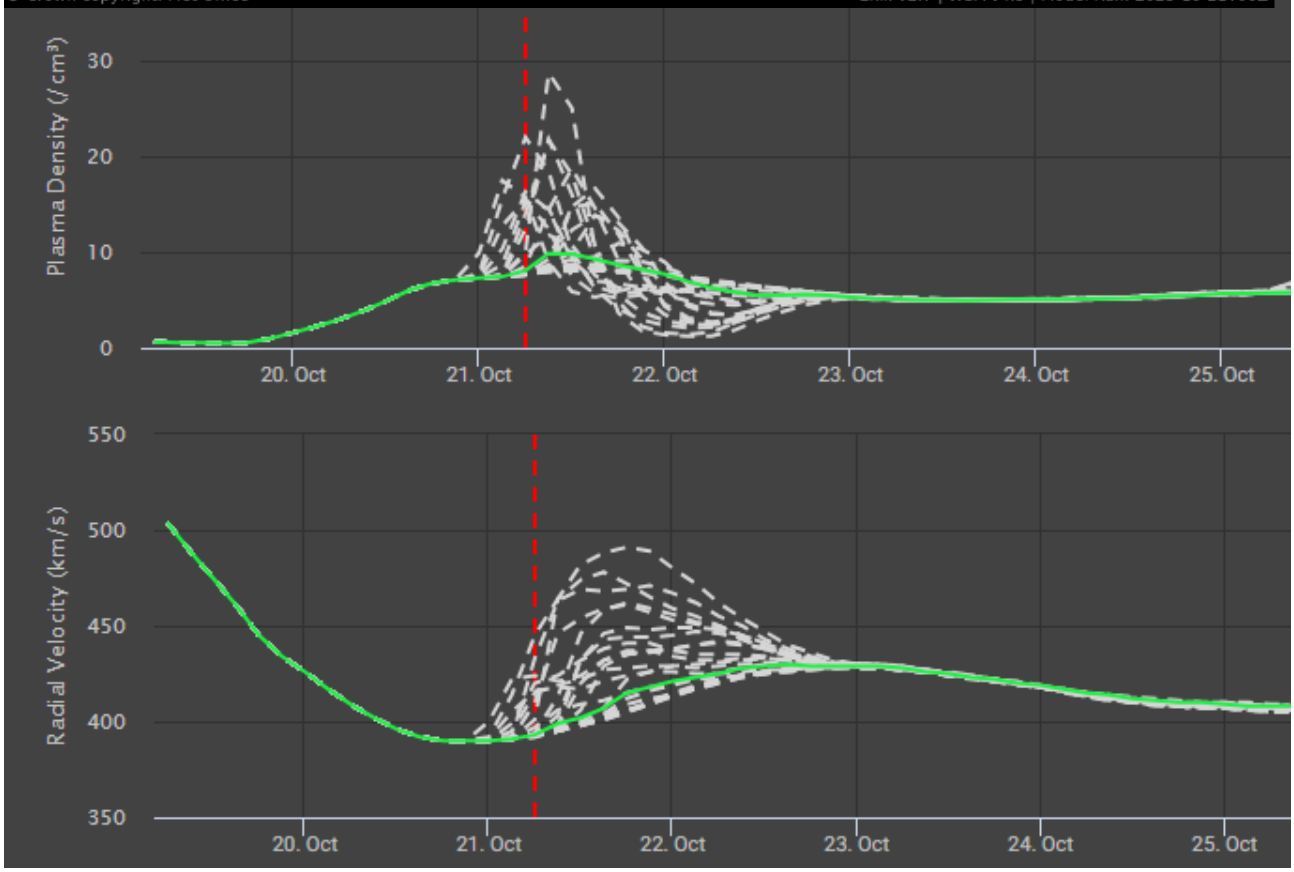
Space Weather Technical Forecast





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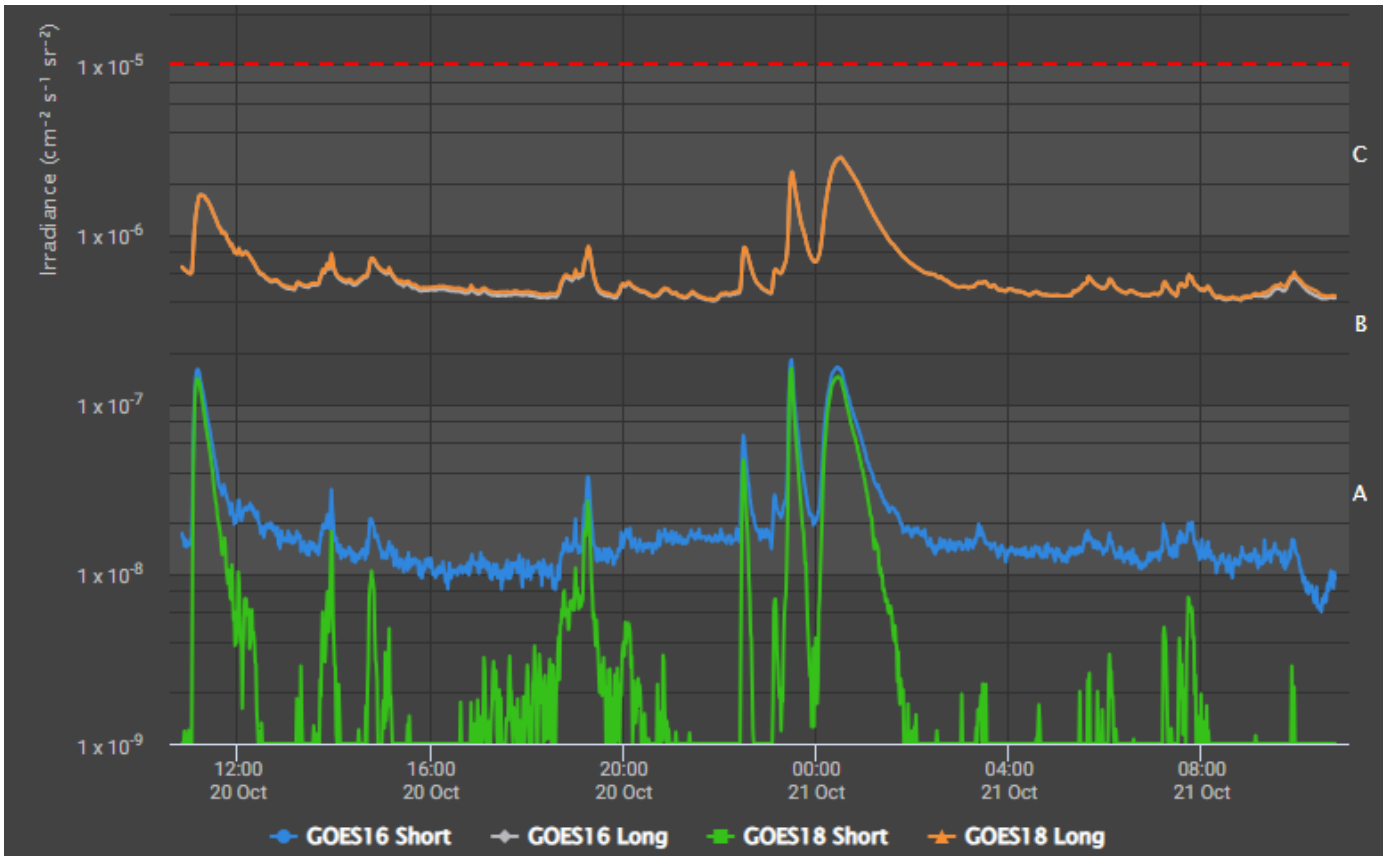
Radio Blackouts - X-Ray Flares:
Six sunspot regions feature on the visible solar disc. All regions are small and simple, with AR3469 in the northwest the most complex looking region and displaying minor reorganisation in the trailing spots.

Activity is likely to remain Low, with only C-class flares, in the absence of any significant development of the regions currently on the visible disc. There is a slight chance of an isolated low level M-class flare. However, towards the end of the period new or returning regions may rotate on from the far side, which is indicated in the slight increase in flare probabilities.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	5	5	5	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: : X-ray trace at GOES 16 and 18, showing minor flares only.



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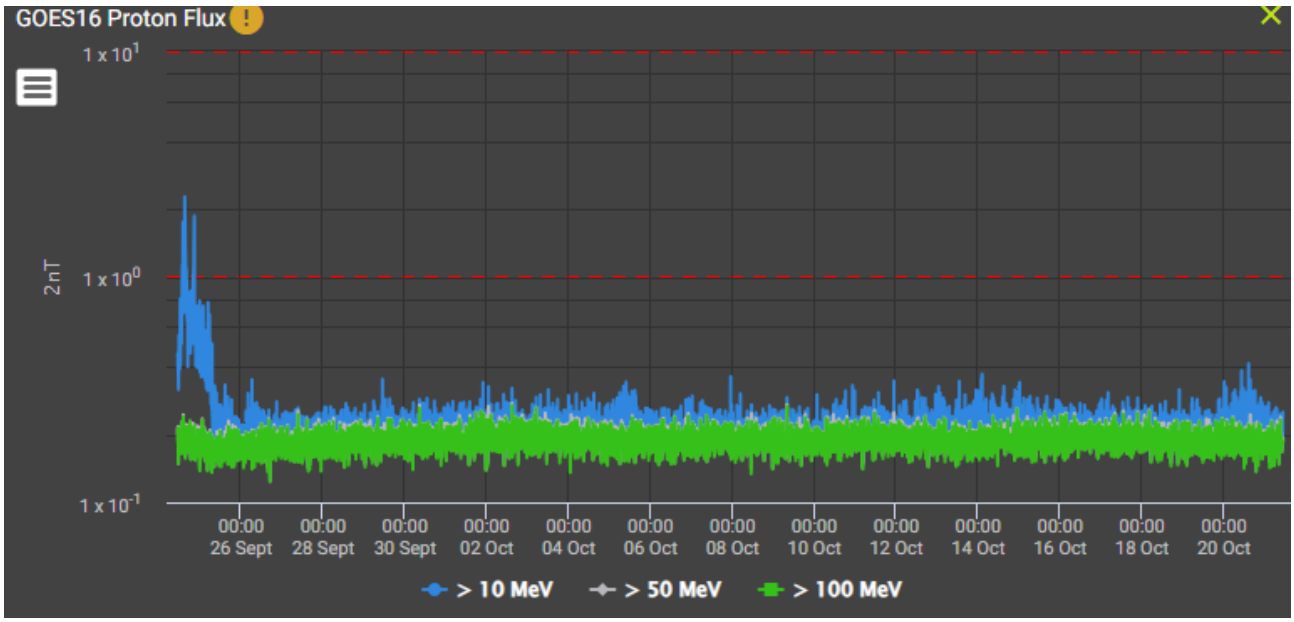
Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10MeV) proton flux observed by GOES16 is most likely to persist at background levels, due to the lack of significant regions on the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Proton flux at GEO from GOES 16 over the past 27 days.



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High Energy Electrons Event (≥ 2MeV):
Electron flux observed by GOES16 at GEO is currently at background levels. Solar wind enhancements are possible through the coming days, with two possible weak CME arrivals, and also the potential influence of HSS activity. These carry low confidence in detail however, and any enhancement is expected to be largely weak. Influence from these features could increase the electron flux in the Van Allen belts during the period, which could bring periods of moderate flux, most likely towards the end of the period.
The associated 24-hour fluence is expected to remain below the Active threshold, as supported by MOSWOC REFM output. However, the model does not take into account any potential CME arrivals. Therefore, fluence levels may rise towards the end of the guidance period and this is reflected in a slight uplift for probabilities in the table above.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: High energy electron flux at GEO from GOES and MOSWOC REFM showing a steady trend below Active (1e8 integrated pfu).

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